



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE/NOAA FISHERIES

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CRUISE REPORT¹

VESSEL: *Townsend Cromwell*, Cruise 01-10 (TC-273)

CRUISE PERIOD: 10 September – 1 October 2001

AREA OF OPERATION: Northwestern Hawaiian Islands (NWHI)

TYPE OF OPERATION: Personnel from the Coral Reef Ecosystem Investigation, Honolulu Laboratory, National Marine Fisheries Service, NOAA, conducted reef assessments/monitoring in waters surrounding the NWHI.

ITINERARY:

- 10 September Embarked Russell Brainard, Edward DeMartini, Stephani Holzwarth, Jean Kenyon, Joyce Miller, Ronald Hoeke, James Maragos, Steve Cotton, Alan Friedlander, Linda Preskitt, and Daria Siciliano. Departed Snug Harbor at 1200 en route to the NWHI.
- 11 September Conducted conductivity-temperature-depth (CTD) at Nihoa Island long-term monitoring station.
- 12 September Conducted Quester Tangent Corporation (QTC) acoustic seabed classification surveys over the southern portion of Necker Bank. Deployed APEX profiling drifter #452 at lat. 23° 19.287'N, long. 64° 27.813'W and surface velocity program (SVP) drifter #24961 at lat. 23° 18.885'N, long. 164° 28.497'W over Necker Bank to examine larval transport and recruitment. Conducted CTDs at Necker Island and French Frigate Shoals (FFS) long-term monitoring station. Tested Tethered Optical Assessment Device (TOAD) deployment, maneuverability, lighting, and recovery procedures.



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- 13 September Conducted QTC acoustic seabed classification surveys over the western bank of FFS. Conducted four, towed-diver habitat/fish surveys over the northern lagoon of FFS. Conducted survey dives to locate potential sites for deployment of FFS oceanographic mooring. Conducted three reef fish surveys at historical survey sites. Conducted three rapid ecological assessments (REAs) of corals and algae. Conducted four bottom grab stations to validate acoustic seabed classifications. Conducted three TOAD drop stations to validate QTC.
- 14 September Conducted QTC acoustic seabed classification surveys over the western bank of FFS. Conducted snorkel surveys of four potential sites for deployment of long-term, oceanographic monitoring buoy. Deployed FFS oceanographic buoy at lat. 23° 51.407'N, long. 166° 16.310'W in 8 m of water. Conducted five fish survey dives at historical sites. Conducted four coral and algae benthic survey dives. Conducted two TOAD survey dives (one drop and one towed) over western bank of FFS.
- 15 September Conducted QTC acoustic seabed classification surveys over the western bank of FFS (71.1 nm). Recovered derelict Fish Aggregating Device (FAD) buoy from outer barrier reef north of the former Whale and Skate Islands. FAD hauled aboard *Townsend Cromwell* for transport to Honolulu. Conducted fish survey at FFS monitoring buoy site. Established permanent 100-m transect at buoy site for coral and algae monitoring. Conducted coral and algae survey at this site. Replaced one shackle on oceanographic mooring. Conducted TOAD drift dive surveys to validate QTC surveys. Conducted QTC acoustic seabed classification surveys around eastern and northern reef slopes surrounding atoll. Departed FFS.
- 16 September Conducted QTC acoustic seabed classification surveys over Brooks Bank and St. Rogatien Bank. Conducted rendezvous with M/V *American Islander* to receive parts and supplies and to meet with CREI marine debris team leader about the ongoing, large-scale marine debris effort. Conducted extensive QTC acoustic surveys over the westernmost of St. Rogatien Bank. Conducted TOAD drift dive to validate acoustic habitat classification. Departed St. Rogatien Bank en route to Raita Bank.
- 17 September Arrived at Raita Bank and commenced QTC acoustic seabed classification survey. Conducted two, towed-diver habitat/fish surveys over the bank ridges at depths of 25–30 m. Initial tow was aborted because of Tiger shark sighting. Conducted benthic and fish REA dives over the ridge depths. Conducted extensive QTC acoustic surveys.
- 18 September Continued QTC acoustic seabed classification surveys over Raita Bank. Conducted one benthic REA dive and two, towed-diver habitat/fish

surveys over bank ridges at depths of 25–30 m. Conducted three TOAD camera drift dives to validate QTC surveys.

- 19 September Continued QTC acoustic seabed classification surveys over Raita Bank. Conducted one benthic REA dive and two, towed-diver habitat/fish surveys over bank ridges at depths of 25–30 m. Conducted one TOAD camera drift dive to validate QTC surveys. Departed Raita Bank en route to Maro Reef.
- 20 September Arrived Maro Reef and commenced QTC acoustic seabed classification surveys. Anchored at west anchorage to begin diving operations. Conducted multiple snorkel dive surveys of lagoon areas to identify suitable sites for Maro Reef oceanographic mooring deployment. Deployed long-term, oceanographic monitoring buoy in 8 m of water inside the lagoon at lat. 25° 26.791'N, long. 170° 38.029'W. Conducted three fish and three benthic REA dives. Conducted QTC acoustic seabed classification surveys throughout the night.
- 21 September Continued QTC acoustic seabed classification surveys until sunrise. Anchored at northwest anchorage for daytime diving operations. Conducted three, towed-diver habitat/fish survey dives, three fish REA dives and three benthic REA dives. Conducted one TOAD drop dive and one TOAD drift dive over Maro Bank. Conducted QTC acoustic seabed classification surveys throughout the night.
- 22 September Continued QTC acoustic seabed classification surveys until sunrise. Conducted four, towed-diver habitat/fish survey dives, three fish REA dives and three benthic REA dives. Conducted one TOAD drop dive and one TOAD drift dive over Maro Bank. Conducted QTC acoustic seabed classification surveys throughout the night.
- 23 September Continued QTC acoustic seabed classification surveys until sunrise. Deployed SVP #24949 at lat. 25° 18.288'N, long. 170° 46.584'W and APEX profiling drifter #454 at lat. 25° 19.234'N, long. 170° 39.862'W. During the night, vessel apparently hit something that caused the starboard engine to overheat. Engine secured for remainder of cruise. Anchored at southwest anchorage for daytime diving operations. Ship's divers evaluated ship's propellers, shafts, bearings, and rudders and learned that starboard shaft bearing appeared to have failed. Conducted three, towed-diver habitat/fish survey dives, two fish REA dives and three benthic REA dives. Remained at anchor throughout the night.
- 24 September Conducted four, towed-diver habitat/fish survey dives, three fish, and three benthic REA dives. Remained at anchor throughout the night.
- 25 September Conducted one, partial towed-diver habitat/fish survey until all boats were recalled to ship to get underway immediately for shipyard in

Honolulu. All operations concluded. Departed Maro Reef en route to Honolulu.

- 01 October Arrived Marisco Shipyard, Barber's Point Commercial Harbor, Oahu at 1200. Disembarked Brainard, DeMartini, Holzwarth, Kenyon, Miller, Hoeke, Maragos, Cotton, Preskitt, and Siciliano; end of aborted cruise.
- 01 – 12 October In port preparing for leg aboard charter vessel *American Islander*.
- 13 October Embarked Russell Brainard, Stephani Holzwarth, Jean Kenyon, James Maragos, Daria Siciliano. Departed Honolulu at 1400 en route to NWHI.
- 14 October Deployed SVP drifter #24946 over Middle Bank at lat. 22° 41.57'N, long. 161° 02.06'W.
- 15 October Deployed APEX drifter #453 near Nihoa Bank at lat. 23° 01.57'N, long. 162° 04.10'W.
- 16 October Recovered Oceanographic Mooring #261-002 from FFS and deployed replacement mooring #261-001 at lat. 23° 51.407'N, long. 166° 16.310'W. Deployed SVP drifter #24958 over Southeast Brooks Bank at lat. 23° 58.72'N, long. 166° 41.64'W.
- 17 October Deployed APEX drifter #456 over Gardner Bank at lat. 24° 31.19'N, long. 167° 55.26'W.
- 18 October Deployed SVP drifter #24953 near Pioneer Bank at lat. 25° 51.00'N, long. 173° 00.63'W.
- 19 October Deployed Oceanographic Mooring #262-002 at Neva Shoals/Lisianski Island at lat. 25° 58.061'N, long. 173° 54.965'W. Deployed SVP drifter #24955 over Bank #8 at lat. 26° 16.6'N, long. 174° 31.4'W.
- 20 October Deployed APEX drifter #457 near Pearl and Hermes Atoll at lat. 27° 25.00'N, long. 175° 25.51'W. Arrived Midway Atoll to rendezvous with charter vessel *Katmai*.
- 21 October Deployed Oceanographic Mooring #261-002 at Midway at lat. 28° 13.073'N, long. 177° 20.641'W. Off-loaded fuel, supplies, and equipment to *Katmai*. Departed Midway Atoll en route to Kure Atoll.
- 22 October Arrived Kure Atoll and deployed Oceanographic Mooring #262-001 at lat. 28° 25.118'N, long. 178° 20.673'W.
- 23 October Deployed APEX drifter #455 near Kure Atoll at lat. 28° 21.48'N, long. 178° 24.84'W. Conducted four, shallow-water-habitat surveys over W and NW reef flats of Kure Atoll. Transfer equipment and supplies

between *American Islander* and charter vessel *Ocean Fury*. Departed Kure en route to Pearl and Hermes Atoll.

- 24 October Surveyed sites for oceanographic mooring.
- 25 October Deployed Oceanographic Mooring #262-004 at Pearl and Hermes Atoll at lat. 27° 51.245'N, long. 175° 48.954'W.
- 26 October Transferred equipment from *Katmai* to *American Islander*. En route to Midway Atoll. Arrived Midway Atoll.
- 27 October Disembarked Brainard, Kenyon, Maragos, Siciliano. End of cruise.

MISSIONS AND RESULTS:

A. A total of 25 reef fish surveys or rapid ecological assessments (REA) were conducted by DeMartini, Friedlander, and Cotton at FFS (11), Raita Bank (1), and Maro Reef (13) to quantify the species composition, abundance, and size distributions of the ecologically and economically important fish taxa. The 11 reef fish survey stations at FFS included the 9 historical monitoring stations and the newly established, permanent oceanographic monitoring buoy. The historical sites were surveyed to continue the reef fish time series that originated in the early 1980s and were conducted annually since 1992. Because of the limited allowable bottom time, only one fish assessment dive was completed at Raita Bank. An additional, forward-looking video camera was installed on the TOAD to evaluate the ability to assess fish abundance over the deeper banks. One video transect was conducted over Raita Bank. The 13 reef fish survey stations at Maro Reef were new sites and included the new, permanent oceanographic monitoring buoy site. Fish densities were estimated at 24 of the 25 stations. All data have been computer-entered. Preliminary comparisons among divers in fish tallies and body size estimates indicate acceptable error. Densities and size distributions at FFS and Maro Reef appear similar to year 2000 data for fishes in shallow water habitats at the respective sites. Reef surveys at Lisianski Island/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Pioneer Bank, Northampton Seamounts, Gardner Pinnacles, St. Rogatien Bank, Brooks Bank, and Necker Bank were not completed because of the engine casualty and early termination of the cruise on 23 September.

B. A total of 26 benthic REAs of corals and algae were conducted by Maragos, Preskitt, and Siciliano at FFS (12), Raita Bank (3), and Maro Reef (11) to characterize the species composition, abundance, percent cover, size distribution, and general health of the corals and algae.

The methods for coral assessment included biodiversity inventories at all sites, quantitative transect surveys at most sites, and permanent transect survey at selected sites. Each of the biodiversity inventories included visual estimates of total live coral cover, lists of all coral species observed within roughly a

50-m by 100-m area, and a visual estimate of the relative abundance of each listed species. Each species was assigned to one of five categories: dominant, abundant, common, occasional, and rare. Currents, visibility, reef geomorphology, sea turtles, marine debris, and other stresses to corals were also noted. Quantitative surveys at the non-permanent sites involved videotaping the bottom habitats at two 25-m transect lines previously laid down and surveyed by the fish team. These tapes will be later analyzed for quantitative estimates of the coverage of coral and other bottom types, and for coral population size distribution. Permanent 50-m transect lines were established at the sites where the NMFS Honolulu Laboratory oceanographic data buoys were installed at FFS and Maro Reef.

At FFS, a total of 40 stony coral and 6 soft coral and anemone species have been reported, the highest diversity of any of the NWI surveyed to date. Raita Bank was characterized by low abundance and diversity of corals, with only seven species reported at the bank, all stony corals. Maro Reef was characterized by generally high coral cover, averaging 50%, and commonly exceeding 75%. A total of 37 stony coral, 3 zoanthid, and 1 anemone species have now been reported from Maro Reef.

The algae surveys were the first known to quantitatively assess the abundance and localized distributions of marine algae in the NWI. Previous algal studies focused primarily on species diversity. Samples of macro, turf, and coralline algae were collected at each site. Two samples of each alga were preserved: one frozen and one preserved in 3% formalin. When possible, dried herbarium samples were also prepared. These samples will be identified and added to the University of Hawaii's herbarium. Data were collected with a point intersect method using a 0.25^2 meter quadrat with 50 points. Twenty points on the grid were randomly selected. Three randomly selected quadrats were completed on two 25-m transects laid by the fish team. The data were used to determine the benthic percent coverage by algae, corals, and substrate types.

In general, the algal community at FFS is dominated by *Microdictyon setchellianum*, with *M. japonica* interspersed. *Halimeda velasquezii*, *H. tuna* and *Laurencia* spp. were common at most locations (visual inspection). The back reef and lagoon algal stands were dominated by *M. setchellianum*, but had higher diversity of other algal species, with scattered populations of *Halimeda* and *Laurencia* spp. The higher energy areas near reef crests and forereefs were dominated by crustose and branching coralline algae, with the calcareous macroalgae *Halimeda discoidea* and *velasquezii*.

Raita Bank provided little protection from currents and predators, and the algal community was limited to *Microdictyon setchellianum* and a few hardy macroalgae, such as *Halimeda* and *Codium*. Dead coral heads and *M. setchellianum* provided added substrate for diverse turf communities.

In general, the algal community at Maro Reef is dominated by coralline and calcareous algal species (sometimes as much as 50%), with much of the reef

substructure stabilized by crustose coralline algae and, at depth, branching corallines and calcareous *Halimeda* species providing much of the sand. Algal diversity did not appear high at the areas surveyed, but *Laurencia* and *Bryopsis* species were common at most locations (visual inspection), and occasional red gooeey algae and *Halymenia* were collected.

- C. Intended benthic REAs at Lisianski/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll were not conducted because of engine casualty and early termination of the cruise.
- D. A total of 25 towed-diver habitat/fish count survey dives were conducted by Brainard, Holzwarth, Kenyon, and one of the ship's divers (Ellis, Callahan, Hill, or Mowitt) to characterize and map the benthic habitats of the shallow water reef resources of FFS (4), Raita Bank (6), and Maro Reef (15). Each towed-diver survey consisted of a pair of divers on towed diving sleds equipped with a downward-looking video camera and a forward-looking video camera, precision temperature-depth recorders, and paired scaling lasers. Brainard and Kenyon recorded habitat complexity, percentage cover of different habitat types (corals, sand, algae, and rock), structural habitat descriptions, and occurrences of marine debris and conspicuous macroinvertebrates. Holzwarth recorded an abundance and distribution of ecologically and economically important fish taxa (sharks, jacks, snappers, groupers, etc.). GPS positions, temperature and depth were recorded every 5 seconds for downloading into an ArcView GIS database. The standard dive protocol consisted of 50-minute transects with divers maintaining the towboards and cameras about 1 m above the bottom followed by a 10-minute safety stop at a depth of about 5 m. The deeper, towed-diver surveys at Raita Bank generally consisted of 25-minute bottom transects. In total, the towed-diver surveys mapped about 75 km of habitat. The towboard surveys at Maro Reef covered most of the major remaining areas not completed during the 2000 towboard surveys. The towboard video data are being used collaboratively with National Ocean Service and UCSC to ground-truth IKONOS multi-spectral imagery for production of high quality maps of the shallow-water coral reefs of the NHWI.

Towed-diver habitat mapping/fish count surveys were not conducted at Lisianski/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, Kure Atoll, Pioneer Bank, Northampton Seamounts, Gardner Pinnacles, St. Rogatien Bank, Brooks Bank, Necker Bank, and Nihoa Bank because of engine casualty and early termination of the cruise on 23 September. Two oceanographic buoys were permanently established to remotely monitor oceanographic conditions over the long-term and transmit vital environmental data in near real-time to the Honolulu Laboratory using ARGOS satellite. These stations are part of a national Coral Reef Early Warning System (CREWS) of buoys and fixed stations being established in U.S. coral reefs to provide advance notification of changing oceanographic conditions that may adversely affect coral reef ecosystems. In addition to the telemetry of a subset of the data in near real-time, the full, high-resolution data sets are recorded internally for downloading during buoy servicing. The monitoring buoy at FFS was moored in 8 m of water at

lat. 23° 51.407'N, long. 166° 16.310'W. This buoy is instrumented to observe: sea surface temperature, salinity, underwater photosynthetically active radiation (PAR), and ultraviolet radiation (UV-B) at a depth of 1 m; air temperature, atmospheric pressure, wind direction and speed, and atmospheric UV-B and PAR. The monitoring buoy at Maro Reef was moored in 8 m of water at lat. 25° 26.791'N, long. 170° 38.029'W. This buoy is instrumented to observe: sea surface temperature at a depth of 1 m; air temperature, atmospheric pressure, and wind direction and speed. Both moorings were established by separately towing the 1200-lb anchor to the deployment site using a 2000-lb lift bag and the instrumented buoy. At the deployment site, Brainard attached the mooring accumulator cable between the anchor and buoy and Holzwarth slowly deflated the lift bag to lower the anchor to the bottom at the desired site. Prior to deflation, the anchor was anchored in place above the site with two small Danforth anchors.

An array of 16 settlement plates were installed at the base of each long-term oceanographic mooring by Kenyon to observe settlement of corals, algae, and invertebrates over time. The settlement plates consist of 8 in by 8 in unglazed ceramic tiles. They are configured with two vertical and two horizontal tiles in each of the four cardinal compass points (N, S, E, and W). These tiles will be removed and replaced annually to observe temporal changes in settlement rates and species composition.

Permanent, long-term oceanographic monitoring buoys and settlement plates were not deployed at Lisianski/Neva Shoals, Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll because of engine casualty and early termination of the cruise on 23 September.

- E. The QTC acoustic seabed classification system was used by Miller and Hoeke to conduct habitat classification surveys at FFS (516.2 nm), W. St. Rogatien Bank (61.3 nm), Raita Bank (477.4 nm), and Maro Reef (425.9 nm). Transit data were collected on Necker Bank (29.0 nm), the three Brooks Banks, East St. Rogatien (38.0 nm), and Gardner Bank (31.8 nm). Total survey mileage for the cruise was approximately 1600 nmi. The QTC was operated primarily during night operations and transits (system settings for the QTC are noted at the end of this report and must remain the same to integrate additional data). These acoustic surveys were validated using TOAD and occasional bottom grab samples. TOAD towed and drift dives were conducted at all survey (not transit) locations with still photos and video being shot at all locations. The photography yielded varying degrees of success based on conditions (e.g., day vs. night operations, camera settings, towing vs. drifting). The TOAD altimeter only worked on the first two deployments, but water depth and fish altitude could be used to determine the distance off of the bottom. Two grab samples were obtained at FFS.

At FFS, orthogonal survey lines at ½ nm spacing were set up for the main QTC survey area on the southwest quadrant of FFS. All lines in this grid were completed in depths between 20 and 100 m. One line was installed around the perimeter of the island in approximately 50 m of water. Five TOAD deployments were conducted. TOAD deployment FFS1 (23–26 m depth) was a tow test in the

SE portion of the survey area over coral rubble and live coral. TOAD deployment FFS2 (13 m depth) was a drop at anchorage north of the survey area over deep, medium-grained sand and sand waves. TOAD drift deployment FFS3 (22 m) in the northeastern part of the survey area was implemented over a flat bottom with sand veneer with occasional algal-covered rocks and some scattered rubble. TOAD tow deployment FFS4 (27–29 m) was implemented in the north central survey area over a varied bottom of live coral. This night tow ended with a crash into coral and the TOAD proved its versatility by providing a sample of rose coral (the camera lens was scratched and the wing shaft bent slightly). FFS5 included two, day-light drift deployments—one just south of the FFS anchorage in hummocky, reworked fine-to-medium-grained sand in 26-m water depth; the second was a redeployment in the FFS4 area (29–30 m) to double-check QTC data and the previous results. Ninety-six minutes of video data and 76 still photos were obtained from TOAD surveys over FFS.

Two transit lines each were run across Brooks, East St. Rogatien, and Gardner Banks. These banks are particularly interesting because they are located at different depths and the QTC data seem to sort primarily by depth in most areas.

At West St. Rogatien Bank, NNW-SSE survey lines at roughly 1-mile spacing and ENE-ESE lines with 1–2 nm spacing were run. This is a small bank at a constant depth and is relatively uniform with respect to QTC data. A single, TOAD drift deployment showed a generally flat, hard bottom with occasional ridges at depths of 56–61 m. Ridge crests were sparsely covered with algae. Fifty-five minutes of video data and approximately 95 still photos were obtained over this very uniform bottom.

At Raita Bank, orthogonal survey lines were completed at 1-mile spacing in the NW-SE direction and 1.5 mile spacing in the NE-SW direction. Additionally, several lines were run along an apparent high-topographic area along the SE side of the bank to locate areas shallow enough for diving. Three TOAD drop dives were conducted at Raita with similar results on this largely algae-covered bank with occasional isolated *Pocillopora sp.* coral heads (varying from approximately 1 to 2% coral coverage) in 25–27 m water depths. A total of 77 minutes of video and 99 still photos were collected at Raita.

At Maro Reef, a partial survey was performed on the NE, NW, and SW of the reef. In the N and NW of the reef, E-W lines at approximately 2-miles spacing and N-S lines at 2–4 miles spacing were completed. Miscellaneous lines south of the island were completed and this survey was terminated as a result of shaft-bearing problems. Two TOAD drift deployments were conducted at Maro Reef. The first, MAR1, (25–30 m water depth) yielded 45 minutes of video and 10 photos over a flat bottom with sand veneer and occasional algal covered rocks. MAR2 produced 24 minutes of video and 46 photos over a hard, rough bottom of dead coral covered by coralline algae with numerous sand pockets and occasional, isolated live coral heads and fleshy algae.

- F. Two APEX profiling drifters and two surface velocity program (SVP) drifters were deployed at Necker Bank and Maro Bank by Brainard, Hoeke, and Miller to investigate larval transport and recruitment of fishes and invertebrates along the Hawaiian Archipelago. The APEX profiling drifters are designed to migrate vertically in the water column in a manner similar to many larval species. They are programmed to submerge to a depth of 100 m during daylight hours and to spend the nighttime hours at the surface transmitting positions and temperature profiles to the Honolulu Laboratory using ARGOS satellites. In this manner, the drifters will simulate the drift patterns of diurnal, vertically-migrating planktonic animals, in which the larval species drift with the wind-driven surface currents at night and with the density-driven subsurface currents during the day. The APEX drifters were deployed over Necker Bank at lat. 23° 19.287'N, long. 164° 27.813'W and Maro Bank at lat. 25° 19.234'N, long. 170° 39.862'W.

The SVP drifters have drogues at a depth of 35 m attached to surface GPS-equipped floats that transmit drift positions with the ARGOS satellites. These drifters record and transmit hourly positions and temperatures. The SVP drifters were deployed over Necker Bank at lat. 23° 18.885'N, long. 164° 28.497'W and off Maro Bank in deeper water at lat. 25° 18.288'N, long. 170° 46.584'W. Four additional pairs of APEX and SVP drifters intended for deployment at Lisianski/Neva Shoals, Pearl and Hermes Atoll, Kure Atoll, and Nihoa Island were not deployed because of engine casualty and early termination of the cruise.

- H. Three, long-term, oceanographic monitoring stations were occupied at Nihoa, Necker, and FFS with standard 500-m CTDs with sampling bottles. These monitoring stations provide time series information about the vertical structure of temperature, salinity, oxygen, and chlorophyll in the NWHI ecosystem. Standard CTD stations at Gardner Pinnacles, Laysan, Lisianski, Pearl and Hermes, Midway, and Kure could not be conducted because of engine casualty and early termination of the cruise. Standard acoustic, Doppler current profiler (ADCP) and thermosalinograph (TSG) data were collected throughout the cruise to describe upper, ocean current structure and surface temperatures and salinities.
- I. A derelict Fish Aggregating Device (FAD) buoy “EK” was removed from the outer barrier reef at the northeast end of FFS (lat. 23° 52.2'N, long. 166° 12.5'W). This steel FAD had about 40 m of ½-inch chain attached. The chain was entangled around the reef substrate in about 20 m of water, temporarily anchoring the FAD to the bottom. Most likely, this entangled chain would have broken free and dragged the chain and buoy over the shallow barrier during the upcoming winter swells. Brainard and Holzwarth attached a line to the chain and Lt. Ellis hauled the chain off the bottom and towed it to deeper water where the ship hauled the buoy aboard for return to the State of Hawaii in Honolulu.
- J. Collection of coral cores was accomplished by Siciliano and Maragos using a coral corer designed and assembled at the University of California, Santa Cruz (UCSC). The corer consists of a pneumatic drill outfitted with a steel cylinder with a diamond sawing edge. The corer permits the extraction of CaCO₃ cores from massive domes of scleractinian corals up to 40 cm in length. A shorter (20-

cm) coring barrel is used to core nodules of coralline algae. A total of four coral cores were collected during the *Cromwell* 2001 expedition. The cored specimens include two heads of *Porites evermanni* at FFS, and one *P. evermanni* and one *Porites lobata* from Maro reef, all collected from a range of depth spanning 8–13 m. Because of the amount of bioerosion on the cored coral heads, most of the cores retrieved were fragmented into small sections. The purpose of this study, which is a collaboration between the University of California, Santa Cruz, the U.S. Fish and Wildlife Service, and the Division of Aquatic Resources of the State of Hawaii, is to determine the growth rate and the absolute age of corals along the NWHI. Differences in growth rate of corals in both a spatial and temporal context are expected. The optimal length of the coral core is 40 cm. This is necessary under the assumption of a maximum growth rate of 1 cm/year allowing the acquisition of a 40-year record, by ^{14}C dating methods. Growth rate and age of corals will be subsequently determined at UCSC. The techniques include examination of density banding by x-radiography of sections of cores to determine yearly growth rate, as well as isotopic analyses to determine absolute age of corals.

- K. In addition to the towed-diver habitat surveys to ground-truth satellite and aerial imagery of coral reef ecosystems, Siciliano performed two other distinct ground-truthing activities: (a) building of a hyperspectral library using a hyperspectral radiometer, and (b) collection of information on the dominant benthic substrates at the surveyed sites. The hyperspectral library is important to understand the spectral characteristics of the different benthic communities, facilitating the interpretation of satellite and aerial imagery collected for the NWHI; information of the dominant benthic substrates at specific, geo-referenced locations guides and corrects (“ground-truth”) supervised and unsupervised classifications applied to the imagery.
- (a) The hyperspectral survey consisted of use of a hyperspectral radiometer (manufactured by Geophysical and Environmental Research Corporation—GER, New York), encased in a custom-made underwater housing. The instrument records upwelling radiance ($^{\circ}\text{W}/\text{cm}^2/\text{sr}$) and (in conjunction with a Spectralon© reference plate) downwelling irradiance ($^{\circ}\text{W}/\text{cm}^2$) in 512 contiguous spectral bands—each 3 nm wide—spanning the visible and near IR (350–1050 nm). The ratio of these parameters yields % reflectance, the physical parameter directly comparable with remotely sensed images. Readings were collected from the most common substrates, including corals, algae, sand, and rubble. A total of 167 readings were collected during the *Cromwell* 2001 expedition. The spectrometer was held at a 45° angle from a distance of 10 cm from the target substrates. Substrate identification to the highest possible taxonomic level (in the case of coral or algae) or a detailed description of the physical substrate accompanied each reading, along with observations on depth, pigmentation, morphology, size of substrate, and photographic documentation.

- (b) The methods for information collection on the dominant benthos at each geo-referenced REA site included estimates of percent cover of biotic (coral, algae) and physical (sand, rubble, rock) substrates using quantitative transect surveys in conjunction with coral and algal surveys concurrently conducted by Jim Maragos and Linda Preskitt, respectively. Transect surveys involved videotaping the bottom habitats at two 25-m transect lines previously laid down and surveyed by the fish team.

RECORDS: The following forms, logs, charts, and data records were kept and given to the Honolulu Laboratory upon termination of the cruise. These include all data captured onto computer storage media during the cruise. All the records are filed there unless indicated otherwise in parentheses.

QTC acoustic seabed classification data
 TOAD digital video tapes (VHS & MDV)
 ArcView GIS track files and shape files
 ADCP DOPPLER ping data files on CD-ROM*
 CTD Station Data Log Sheet
 Seabird CTD data files on CD-ROM*
 Digital camera photos (JPG file format) on CD-ROM*
 Marine Operations Log
 Project Area and Operations Chartlets
 Scientist's Log
 SCS data files (raw & compressed) on CD-ROM*
 Station Number and Activity Log

* All data files are together on the same (1) CD-ROM.

SCIENTIFIC PERSONNEL:

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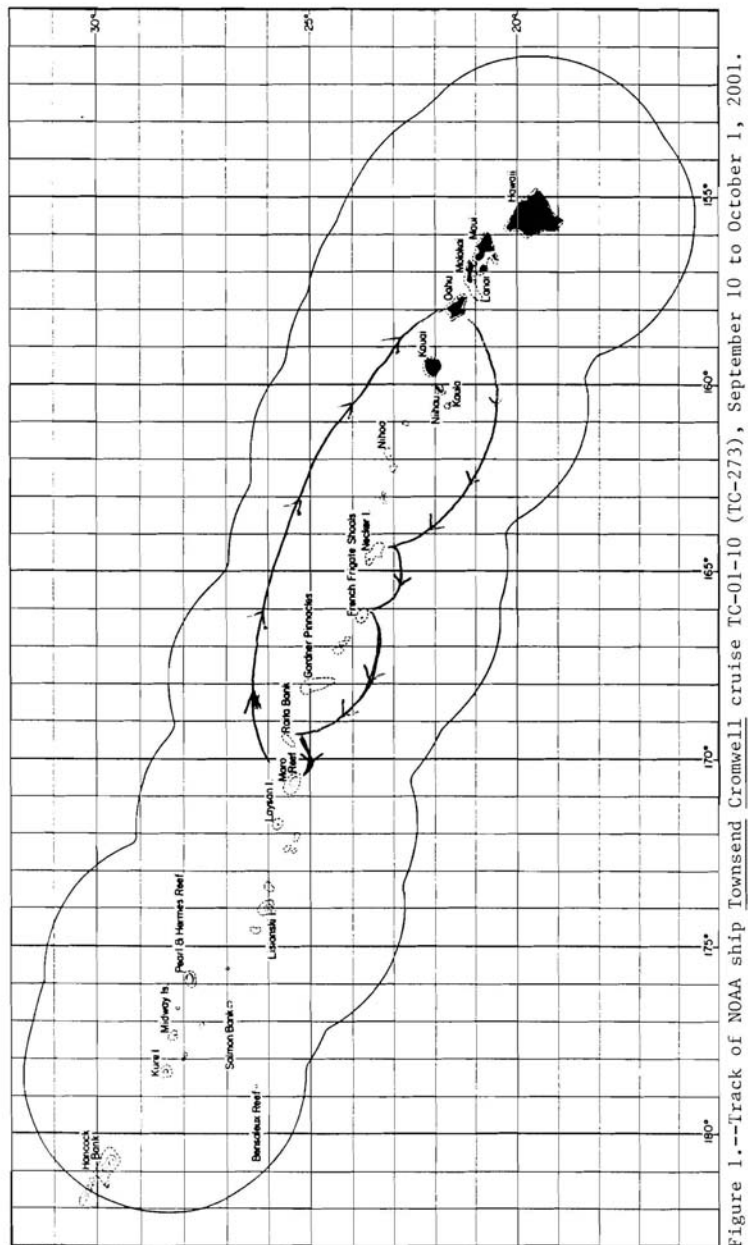


Figure 1.--Track of NOAA ship Townsend Cromwell cruise TC-01-10 (TC-273), September 10 to October 1, 2001.